NOAA Fisheries Panama City Lab Biological Studies and Data Processing For Fisheries Assessment and Management (May 2013)

Introduction:

The objectives of the Panama City Laboratories' Fisheries Biology Program are to provide biological, life history and ecological characterizations for economically important reef fish and pelagic species in order to improve precision of estimates for stock assessment and inform ecosystem-based modeling approaches, by 1) determining the age frequency, growth and longevity of fishery species in the Gulf of Mexico and Atlantic, 2) monitoring demographic structure of key species on important time and spatial scales, 3) determining basic reproductive strategies and maturity parameters 4) estimating reproductive potential via fecundity and adult condition and 5) determining population structure, dispersion, and source-sink dynamics via stable isotope analysis and microchemistry of tissues.

Program history overview:

History

- Began projects in early 1980s in response to mackerel management needs and expanded based on Gulf reef fish management plan in early 1990s and bluefin tuna in late beginning in 2010.
- Original objective: Characterize age and growth, basic reproductive traits, migration and stock ID for about 6 key species (2 snappers, 2 groupers, 2 mackerels).
- Work was historically coined as "bioprofiles" at Panama City.
- Funded with internal MARFIN money and other non-dedicated funds.
- Early work was "research" centric approach as opposed to "production" centric.
- Late 1990s expansion to meet demands of age-structured models due to re-evaluations of Gulf red snapper assessment.
- Began to dovetail ageing with Gulf States (under GulfFIN) in 2003-2004 (primarily for red snapper).
- In 2003, SEDAR begins to drive work objectives (for Gulf).
- In 2010 otoliths from bluefin tuna began to be processed for age determination and stable isotope analysis to determine source population (i.e., eastern or western Atlantic).
- While production-style ageing is now the main bioprofiles activity in terms of cost, other activities includes reproductive processing and histology, data base management, fishery-dependent sampling, life history, stock ID and methods research.

The SEFSC Panama City Laboratory began receiving biological hard parts during the late 1980s. A majority of these samples were collected from the major reef fish and pelagic species from the Gulf of Mexico (reef fish: snapper: red, vermilion, gray, lane, yellowtail; grouper: red, gag, scamp; pelagics: king and Spanish mackerel). These samples and corresponding field data sheets were submitted to the Lab. In the earlier years (1985-1995), individual port agents sent their data and hard parts to Panama City, any missing

data (e.g. capture location, gear, reporting area) were communicated between the original port agent and the Lab and subsequent completed data was batched to the Trip Interview Program database from Panama City to Miami. The original datasheets, housed at the Panama City Lab for 1985-1996 years, are considered to be the originals since these are the datasheets that accompanied the hard parts.

Data processing

Prior to 1998, Panama City Lab did not have an established database that held both the meristic and trip associated data. Therefore, the Lab established its own database in MS Access along with quality control guidelines (see Folder: Ageing Protocols, NOAA PC AGR Manual 2008) in regard to the interpretation of source-specific datasheets. As the internal program grew the realization of data sources that needed to be accommodated also grew.

Primary Biological Sample Data Sources:

- CO-OP Cooperative Fishing Effort:
    - Samples collected by awarded Cooperative Research Proposals (CRP)
- FMRI Florida Marine Research Institute
    - Samples collected during scientific surveys as part of the Fishery Independent Survey.
- HB Beaufort Head Boat
    - Beaufort Head Boat (HB) samples are collected during interviews of registered Head Boats and samplers are supervised by biologist from NOAA Fisheries, Beaufort, NC.
- MRFSS Marine Recreational Fisheries Statistical Survey
    - The Marine Recreational Fishery Statistics Survey (MRFSS) is a nationwide program implemented to establish a reliable database for estimating the impact of recreational fishing on marine resources.
- MSLAB Mississippi Laboratory
    - Samples from the NOAA Fisheries Mississippi Laboratory are collected during scientific cruises at sea as part of the Fishery Independent Surveys.
- NCDMR North Carolina Department of Natural Resources
    - A division of the North Carolina Department of Marine Environment and Estuarine Resources. King and Spanish mackerel are the only species received from the North Carolina Department of Marine Fisheries (NCDMF),
- PCLAB Panama City Laboratory
    - Panama City Laboratory collects commercial, recreational, and scientific survey samples.
- RECFIN Recreational Fisheries Information Network
    - Recreational Fisheries Information Network (RECFIN) is a sampling program similar to MRFSS which intercept biological samples from recreational vessels. RECFIN is a Gulf State Marine Fisheries Commission program. Most of the RECFIN samples are sent to our facility by the state of Florida (FWC/FWRI).
- Observer Programs

- POP Pelagic Observer Program; Pelagic Observer Program samples are collected by fishery observers from US commercial fishing vessels
- SBLOP Shark Bottom Longline; Otoliths and gonads collected from NMFS Shark Observer Program are collected onboard commercial fishing vessels.
- GOP Galveston (Reef Fish) Observer Program; Otoliths and gonads collected from NMFS Shark Observer Program are collected onboard commercial fishing vessels.
- Quantec contract and the Northeast Regional Office: Otoliths, gonads and spines from highly migratory species.

- TIP Trip Interview Program

  TIP Port Agents collect mainly commercial and some recreational samples.

As the Trip Interview Program (TIP) was the mainstay of the samples collected and data source the focus was to accommodate the program via the Interview Number (source number). This was used to cross-reference and recover any data not written on the original data sheet from the TIP source databases (SEFSC data bases SEFHOST, DELPHI, TIP ONLINE). It was at this proofing stage that the program encountered errors that were irresolvable given the original datasheet and the lack or inconsistency of the data in the TIP database. Errors consisted of missing interviews in the source database, no gear or no capture information in the TIP database but recorded on the original datasheets, hard parts existed but were not recorded in the TIP database and incorrect meristic information or incorrect weight type code in the TIP database. To resolve these issues the Lab would contact the submitter directly to validate corrections as well as use as a learning tool to help prevent similar errors in the future (see Folder: Ageing Protocols, Data Quality Control, Allman et al Q/A- Q/C,).

In 2009-2010 it became apparent that duplication of data entry and effort (man hours) was causing inefficiencies simply because there was not a centrally usable data base link between the biological sampling collections and the biological samples data (derived products) at the Panama City and Beaufort Labs with the SEFSC. To address this the SEFSC, through Fishery Information System (FIS) funding, developed a Biological Sampling Database (BSD) which created a new online database system for storing biological sample reading data linking it to the existing TIP database system allowing users to view both sources of data through one interface (see BSD Folder, BSD Procedure Manual_ARTECH for specific details). Currently BSD integrates TIP sampling data and the biological data but there are plans to migrate other data sources of biological sampling such as headboat data and observer programs as well.

Processing of Biological Samples:

Age Sampling and Processing Levels

- NMFS sampling for hard parts has increased steadily since 1990 (<5,000/yr) to 2012 (> 85,000/yr) representing over 80 species/yr (>89% from TIP program).
- While PC Lab archives contains > 80 species/yr, the bulk is still comprised of the key 6 species with red snapper dominant (approximately 161,700 red snapper

otoliths in the archive since 1990 of which 66,000 have been aged by the PC Lab). Focus of work now encompasses 10 additional species.

- PC Lab has regional focus on GOM except for historical processing of king and Spanish mackerel otoliths from S. Atlantic and recently bluefin tuna from the Atlantic
- In conjunction with GulfFIN, about 9,000 Gulf red snapper ages are prepared per year. For the 2012 Gulf red snapper bench mark assessment the PC Lab and Gulf States provided ~25,000 age records which is in addition to the 90,000 ages provided for the previous assessment. Except for red snapper, the PC Lab contribution levels are nearly exclusive for other federally assessed species (SEDAR) in Gulf of Mexico.
- Except for red snapper, GulfFIN (state) contribution levels are nearly exclusive for a few species managed at the state level (e.g., mullet and spotted seatrout).
- PC Lab processing levels varies from about 8,000 to 20,400 age structures per year based on database query (from 1998 to 2011). The trend has been toward increasing processing levels over time.
- Peak production by PC Lab totaled 20,400 ages in 2009 and entailed backfilling database (multiple years samples processed this tally).
- Targets are typically 2,000-4,000 ages per year per species based upon 500+ otoliths per major strata with major strata identified as based upon fishery, gear, and region; a protocol shared with GSMFC (See Thompson, 1987).

Otoliths

Otolith or hard part derived age data are used to estimate abundance at age and growth patterns of the stock. Since age represents the basic data required to conduct population demographic analysis, increasing output of age data together with improved spatial information has been a Lab priority for enhancing stock assessments. Methods and structures used for age determination vary among species. Sagittal otoliths are aged whole if possible or sectioned using petrographic-type sectioning saws. Some species such as gray triggerfish are aged from dorsal spine sections. Sections from each ageing structure are mounted and viewed using stereomicroscopes. Mounting includes use of epoxy (e.g., Loctite, Epofix resin), thermoplastic, or polymer mounting media (e.g., Protexx). Otoliths are polished if necessary and examined at 40-75x using transmitted or reflected light. The number of visible annuli and margin type will be recorded. Otolith margin characteristics are useful in determining the period of annulus formation and in adjusting the ages of those fish which are in the process of forming an annulus. Ages are assigned by a primary reader. Depending on sample sizes, second or third readers also make age determinations. Otolith reference collections are used to assure that all otolith readers are ageing consistently. The degree of reader disagreements or error is determined using precision estimates and, in turn, used as estimators for ageing error. Every otolith that is submitted to the PC Lab is archived for future access. Based on the number of samples archived per significant strata sub-sampling of otoliths is done where the number of otoliths is upwards of 500 or more per that significant stratum (Thompson 1987; see Sub-Sampling folder).

Fish Reproduction

Reproduction in tropical to sub-tropical waters may occur over much of the year requiring extended seasonal monitoring. Further, more hermaphroditic species and more diverse reproductive strategies are encountered in lower latitudes (Shepherd et al. 2013). In the sub-tropical Gulf of Mexico, 43% of teleost species under a Fisheries Management Plan are hermaphrodites (see list; Gulf of Mexico Fisheries Management Council 2012). Sex-based information for managing hermaphrodites is vitally important (Shepherd et al. 2013), but assessing the sexual transitioning of hermaphrodites requires histological processing in addition to baseline reproductive classification of fishes, at increased cost and effort. Accurate and precise measurement of reproductive potential in sub-tropical and tropical fishes requires frequent sampling, timed to intersect an (often) annually variable reproductive season. Biological sampling of gonads, together with otoliths, can provide estimates of spatial reproductive patterns, age- and size-at-maturity and fecundity, filling data gaps and meeting the needs of higher tiered assessments. The SE fisheries have historically relied on biological sampling collected through the interception of commercial catches at fish houses and dockside (TIP) which provides a cost-effective supply of otoliths to characterize the age-structure. However, harvested species are typically thoroughly gutted at-sea thus limiting the retrieval of reproductive tissue and stomachs dockside. As well, very little detailed spatial, environmental and habitat information is gained from fishery-dependent sampling. In the past, fishery-independent surveys in the Gulf of Mexico were a minor source for biological samples and associated information, as coverage in space and time was inadequate and sample sizes too small to characterize population and ecosystem traits. We are working more closely with observer and fishery-independent survey programs as they have a much greater potential for obtaining size and vital rate information along with gonad samples, condition and maturity data in concert with reproductive cycles. Gonad processing is detailed in NOAA PC AGR Manual 2008. Additionally we are developing optical scanning methods to count and identify oocyte stages. The need for more efficient fecundity methods, in part, is a response to increased field sampling of reproductive tissues that is occurring due to better support for observer and cooperative research programs. The overall objective is to increase both the amount and the quality of data on reproductive potential available for stock assessments since assessments can be very sensitive to reproductive inputs and underlying reproductive assumptions.

Otolith Chemisty

Stable isotope and microchemical analysis allows a determination of whether distinct geochemical signatures can be detected in tissues and hardparts of marine species. Determining nursery sources to adult populations enables an understanding of whether recruitment within a particular region or management unit is self-sustaining or supported from other areas. Otolith chemistry for example, has been a powerful tool that has enabled estimates of spatial mixing rates by providing a measure of movements between nursery and adult feeding and breeding grounds. This is a relatively new area where PC personnel are developing expertise. Established methods are being used to assess chemical signatures of otolith cores which allows discrimination of the number of juvenile areas that produce adults of distinct year classes. Thus this work is conducted in conjunction with hardpart ageing. Cores are extracted from otoliths via micromill precision drilling, decontaminated and prepped (pulverized and dissolved) for inductively

coupled plasma mass spectrometry and stable isotope ratio mass spectrometry. The Lab has recently built a clean room, acquired a micro mill, RO water filter, and hepa filters to do in-house processing for micro constituency work but is not yet into production mode. (See otolith chemistry folder for details)

QA/QC and Sharing Work Products

Much of our work products are combined or dovetailed with results from other labs and agency partners. Therefore quality control and coordination between partners is essential. To date, efforts have included periodic conferences and annual workshops for personnel (state federal and academic) from the Gulf of Mexico involved in fish age determinations and survey/reef fish tape reading. These forums enable training and method calibrations but also involve shared reference sets and exchanges of materials between readers to obtain estimates of precision and bias in derived estimates (see Folder: Ageing Protocols, Allman et al QA-QC). Additionally, species specific ongoing collaborative workshops, such as bluefin tuna (See Ageing Protocols, BFT ageing protocols folder) are conducted to establish International acceptance of ageing standards.

Future planning:

Based upon funding and long-term support for fisheries monitoring, expansion of biological studies necessitates improvements in state and federal task and data sharing, application of barcode tagging to track and archive specimens, and feedback/consultations with field collectors and developing means of quality assurance and control. Databases will be assembled incorporating unique identifiers of specimens by gear and program: 1) trip number, 2) haul number, and 3) specimen number. Application of bar codes will be developed in synchrony with an on-board electronic data collection system not only to track specimens but to facilitate laboratory workflow and to enable a chain of custody. Annual review of the databases and inventories will be conducted: 1) for quality assurance of the data sets and to provide a report to program managers of the levels of sampling (similar to the annual reports currently produced for otolith collections and SEAMAP results), 2) to compare information from data collectors on biological results (e.g. sex and maturity staging, habitat classifications, use of field codes) to reconcile and/or develop means to inform and train samplers, and 3) to assure that data assembly is completed and to conduct preliminary analysis well in advance of assessment and ecosystem modeling workshops. Broader coordination and training will occur between the state and federal partners following the model of annual workshops by Gulf otolith processors and reef fish video tape readers, sponsored by the Gulf States Marine Fisheries Commission, Florida FWC and NOAA.

Vital rate inputs derived from life history data, together with information on movements and habitat associations are needed whether for single species or ecosystem approaches to management. With increased vital rate information for more species, foregone yield can be estimated in damage assessments (such as NRDA). Expanded trophic analysis directly enhances the movement towards ecosystem-based management. Trophic data is urgently being sought by researchers constructing models of mortality and food-web interaction. Isotope analysis of trophic linkages enables better understanding of habitat connectivity and energy subsidy (e.g., from coastal to offshore areas) which drive fishery yields and points to regions, and habitats within regions, where more management

attention is needed. The added information can also improve management by allowing functional groupings—classification of species by behavior, habitat, and trophic levels. Expanded reproductive work will improve estimates of reproductive potential for key Gulf species. Egg production models can be developed which incorporate adult spawning parameters and egg and larval survey results to yield empirically derived annual output of female spawning biomass with associated variance.

Weaknesses

- While often overlooked and underfunded, improved training, coordination and quality control of tasks completed in the field, the laboratory, and for database management can markedly improve and expedite information sharing.

- Data base management at the Panama City Laboratory is constrained by reliance on MS Access data bases maintained by biologists performing multiple duties. The growing size and complexity of the system, together with increased data calls are stretching the limits of available staff and resources. An Oracle based system with a full-time data base position and IT support for server storage and backup are needed to meet the ongoing and growing demand.

- Limitation of research time: Understaffing in some areas together with limited budgets and increased rate of assessments have constrained staff time to conduct research (e.g., 2012 survey of Bench Scientists). This limitation on research time may ultimately compromise the quality of work products, reduce innovation and adversely affect personnel retention. Support for conferences and professional development needs to be enhanced. The research career path process needs to be resumed.

- Improved internal communication is often highlighted as a need (e.g. federal employee feedback surveys). The limitations on communications and collaborations may be particularly acute within the SEFSC given the center's multiple disparate regions of responsibility and with staff dispersed across several facilities. Senior staff retreats, employee exchanges, more mixing of field, lab and analytical staff, expansion of research time, and conferences may alleviate some of these challenges.

Needs / Recommendations

- Target minimum annual production of 50,000 age structures to meet assessment needs for about 18 finfish species.
- Provide dedicated budget.
- Recommend supervisory biologist (B.S or M.S. level) at sub-branch level or branch level (Ph.D.) to oversee production age group (as in other centers).
- Need better means to manage contractors such as ability to specify contract details for production work, and include performance measures and rewards.
- Sampling levels for the private recreational sector are overall low. Consider dedicated funding to increase age structure sampling levels (Through current federal sampling such as the TIP program, or via RecFIN). In general there is a need for more focus on recreational programs, interests and related research.

- A focus on improving reproductive estimates should come from a dedicated research program and expanded observer-based or fishery-independent sampling.
- As well, expertise and program development is needed to expand trophic and genetic studies within the SEFSC and integrate oceanography/environmental research with biological studies.
- Staffing for key areas at Panama City includes database and IT positions.

Funding / Personnel / Costs

- Personnel: FTEs 2 full time and 5 staff assigned partial duties to bioprofiles, Contractors: 5 full-time and 5 part-time contractors (2011-2012).
- Funded by various sources including: internal MARFIN, Red Snapper Research, Expand Stock Assessments, Fisheries Management.
- Annual labor costs for bioprofiles tasks exceeds $960,000 (2012).
- Budget the work (realistic): Based upon $20.00 per age structure with 30% for QA/QC and 20% for overhead = $1.56 million.
- Thus cost estimates for 50,000 age structures and associated work ranges $1 - 1.6 million.

Literature Cited:

Gulf of Mexico Fisheries Management Council. 2012. Species Listed in the Fishery Management Plans of the Gulf of Mexico Fishery Management Council. http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/species%20managed.pdf). 7p. Rev. 05/31/2012.

Shepherd, G., K. Shertzer, J. Coakley, and M. Caldwell (Editors). 2013. Proceedings from a workshop on modeling protogynous hermaphrodite fishes, Raleigh, NC. 33 p. Available from: Mid-Atlantic Fishery Management Council, 800 North State Street, Suite 201, Dover, DE 19901, or online at http://www.mafmc.org

Thompson, S.K. 1987. Sample size for estimating multinominal proportions, The American Statistician 41(1):42-26